Mint of the United States
May 6. 1838

Franklin Peale Esqr
Dear Sir

Being about to embark for Europe on a mission connected with the affairs of the Mint, which has been the subject of our late frequent conversations, it is proper to present to you the views entertained in recommending to the department the design on which you are now entering, and the points of chief interest which are committed to your investigation.

As introductory to the observations I am about to offer, you are herewith furnished with a copy of my communication of the 27th April to Wm. McLane Secretary of the Treasury, in which the principal objects of the intended mission are recited, reference being had to a communication held with him at Washington, when the design was fully submitted for his consideration, and on a developement of its objects promptly approved. You will find also herewith your designation as Assistant Assayer of the Mint, the character in which you will be considered as standing related to the institution, during your mission in its service. I inclose also a letter from the Secretary of State and of the Treasury to the representatives of our Government in Paris and London, which will secure to your enquiries their favourable regard and influence, both of which however I have no doubt would otherwise be cheerfully

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rendered for the promotion of the objects in view. I also ~~carried with me~~ Letter to Mr Harris, Chargé of the United States at Paris, with whom I have the satisfaction to be personally acquainted. —

The prominent subjects of enquiry for which this mission has been recommended, are, as you are aware, the improved process for separating gold & silver, & the assay of silver by the humid mode. In addition to these, an attentive notice of the combinations of machinery & manipulations, employed in any of the operations of foreign mints, coming within your observation, will claim your regard, together with whatever practices may have been approved of on long experience of their utility, for promoting economy in those establishments, where very extended supplies of bullion present many advantages for determining what is best. Various minor points will also be mentioned as they have occurred to myself on reflection, or been suggested by ~~the~~ Officers of the Mint, and others will ~~be likely to~~ present themselves to you in the progress of your observation while abroad. On the principal topics referred to, a few remarks are subjoined in their order.

1. The process of separating Gold & Silver from each other, or, as it is more neatly denominated gold & silver parting. This as you know is the process formerly called by chemical writers, quartation, from the near approach of the proportion of the two metals to that of one part, ~~of the metal to be separated~~ in four of the whole mass, which was found requisite for the successful action of the solvent employed.

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The agent employed in the process of parting in the Mint of the United States, has been usually the nitric acid, as also, it is believed, in Europe until within late years. The sulphuric acid has been, but to a small extent, used for this purpose with us. Vessels of the character required for its safe and successful application, have not hitherto been readily obtained here, and the aggregate expense of a suitable establishment has been perhaps regarded as disproportioned to the demand for this process heretofore. Later years have, however, thrown into the United States more frequent supplies of the precious metals in a state requiring this operation. Under these circumstances our attention has been drawn to the improvement in the vessels and combinations employed in this process for some years past in France, under many advantages from the abundance of bullion there offered to the refiner; and it has been considered worthy of enquiry to determine on the expediency of introducing this improved process into the United States. An enquiry which must embrace the expense of the requisite vessels, structures and arrangements, and all the manipulations in detail, with the most successful method of disposing of the noxious gases developed during the operation. In few words, it is required to solve well the following general proposition viz. — A bar of Goldish silver being given, in which the quantity of each

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metal has been strictly determined by assay - to exhibit those metals in a separate form, by the agency of the sulphuric acid, in safe vessels, in the shortest time, with the least expence, without injury to the opperator, or the diffusion abroad of noxious vapours.

The economy of the process involves, of course, that there shall be the least possible waste of precious metal, viz. no waste, and demands that the agents employed shall be recovered, by adequate expedients, in the most productive forms.

An operation in magnitude is that in contemplation, and not a delicate analysis of a minute quantity - a business opperation, in which the whole procedure shall have reference to large results. Every progressive step with the manipulation pertaining thereto is important, and should be rendered familiar. Excuse minute illustration. A bar of goldish silver for example of 72 lbs troy, about 25 kilograms, is carefully weighed and assayed - be sure that this assay is perfect, indicating the average fineness of the mass. This bar is granulated, exposing thereby an extended surface to the action of the acid. How granulated in the best laboratories - it is well done here, is it better done abroad - A certain weight is then introduced into a proper vessel, of a given size and form, and the acid poured thereon - What weight - what vessel, and size and form; and how much acid - and of what degree of purity and strength; and how are the purity

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and strength determined. Is the metal or the acid first introduced - the whole quantity of both or either at once, or in divisions. What precautions to obviate disaster in the process - what the contrivances for disposing of the offensive vapours. Of the given acid what quantity dissolves a given weight of silver variously alloyed - in what time, at what temperature. Is the solution saturated with the first dose of silver, or is the acid used partially to dissolve the silver and then reserved to be poured on a fresh quantity. The solution is at last it is presumed a saturated solution, and at the end of the process is at the boiling temperature. What guards to prevent ~~dangerous~~ explosion in decanting the solution - how can it be diluted without danger while at the boiling temperature of concentrated sulphuric acid, and how prevent crystallization in cooling if not promptly diluted. How soon can the whole of the silver be precipitated - what is the precipitant preferred, and how is this best recovered in an available form. The gold is cleared of the sulphate of silver by the filter, then dried and melted - cleared by the filter - a highly important device, to be studied well. It is dried - how dried - how melted - with what additions - in what vessels - with slow or rapid fire. When melted with every precaution and the gold bar assayed, if all parts of the process have been perfectly successful, the weight should correspond with the indication of the assay, and the gold should be perfectly fine. But it is probable that the gold will not be perfectly fine, the weight of the bar should therefore be

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greater than that of the gold indicated, and on being apparged
should be found to contain the whole quantity of gold
estimated to be in the original mass. ~~If there can become~~
~~any~~. A corresponding process is applicable to the silver, after precipitation,
corresponding results, ~~if the bar be right~~. Does the acid
dissolve every particle of silver even when the disproportion
of this to the gold is such, that the latter is reduced by the
process of parting to a state of the most minute division.

The process having been pursued successfully
throughout all its details in a single bar, the question of
quantity to be accomplished in a given time, is merely
one of proportion in the several parts of the establishment, and
the constituents of the operations.

Devise and deliniate the best plan of a
Laboratory, complete in all its appendages for the parting
of gold & silver, regarding the process as an object of
individual enterprise, profitably conducted, to a given extent
per day. Please to exercise your ingenuity in perfecting such
an arrangement, as shall combine the efficiencies and facilities
of the best conducted refineries within the reach of your
observation. An apartment of the Mint 54 feet by 37,
accommodated with numerous flues, may be appropriated to
this purpose. Such a modification of the plan devised,
as would be feasible in the apartment referred to, claims
therefore your special consideration.

The precipitants used to recover the silver
from its solution in the sulphuric acid, will
vary according to the occasional demands for their

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respective sulphates. Ascertain well the most convenient boilers for concentrating the solution, and the crystallizing vessels employed in each case. The form and capacity of such vessels, it is believed, will influence sensibly the perfectness and magnitude of the crystals, on which their value in commerce very much depends.—

In the memoirs on the subject of parting by the sulphuric acid which I placed in your hands, much preliminary information is found. Your own personal observation and actual engagement in the Laboratories must do the rest. The prices at which the parting is performed in France, for different alloys, are to be carefully ascertained. A very material object of your mission is to be regarded as unaccomplished, until you have become familiar with every thing requisite for directing the formation of an establishment, de novo, embracing the proper structures, arrangements, implements and facilities, and until you shall have acquired a good share of adroitness in the actual manipulations, from the granulation of the metal, until its component parts are seperate by rendered, and the agents recovered back under the most available forms.

In what has been hitherto said of parting by the sulphuric acid, the refineries of France have been especially in view. It is however stated on respectable authority, that this process has been very lately adopted, with some improvements, in London. There also, should your visit be extended to that place, it will claim your attention.

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2. The assay of silver by the humid mode, will be an object also of very careful regard. The memoir of the commission charged by the French government in 1829 - 1830 with an investigation of this process, has been placed in your hands; from which you will have perceived the grounds on which this proceedure was founded. I have briefly alluded to them in my communication to the Secretary of the Treasury.

We are well aware, that the process of cupellation is not perfectly free from irregularities. These have however been so carefully considered and guarded against here, by judicious precautions and corrections, that it is believed the silver assay by cupellation is no where performed with more success. But with all these corrections it cannot be rendered, invariably correct in a given instance, though its inequalities may neutralize each other in a succession of assays. If the humid assay for silver, can be rendered facile and expeditious enough for daily practice, the achievement will be highly useful. The theory of the process assimilates it with the gold assay in the constancy of its results. The accuracy of the ordinary gold assay depends on that law by which the nitric acid dissolves all the silver from a mixture of silver and gold, or leaves always a given residue of silver undissolved. The accuracy the proposed silver assay, by the humid way, depends on the precision with which the silver thus dissolved can be precipitated and its quantity determined, either by means of the precipitate itself, or of the material

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required to effect the precipitation. The latter has been recommended by the ~~committee~~ commission alluded to, and may therefore be regarded as on the whole preferable. It seems however to be the more protracted of the two. You will carefully study this process, if it be still in practice in Paris, and become perfectly acquainted with it by frequent repetition thereof with your own hands, under various proportions of different alloys skillfully combined as tests of the opperation.

In thus prominently inviting your attention to the humid Assay for silver, it is far from my purpose that you should omit to become perfectly familiar also with the Assay by cupellation as performed abroad. It is altogether probable that for its facility and brevity, this is still much in use in Assay offices and refineries in Paris. In some one or more of these, the best being as far as possible selected, it would be useful to become intimately acquainted with the whole art of the cupel furnace as employed there. In England the dry assay for silver still it is understood prevails, guarded and checked, probably, by methods analogous to those adopted here. In that Country therefore in the event of your visiting it, this process will be critically investigated.

Much depends, you will have perceived, from the reports of the French commission, as well as from other authorities, on the quantity and quality of the alloy, in determining the degree in which the result of the cupel assay is erroneous as commonly applied. Not a

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little also depends on the fit proportion of lead required by the variable character of the alloy present. A good series of these proportions is given by Aitken. That followed here proceeds on similar principles. You will ascertain those which practice has suggested to the most skilful and experienced assayers abroad.

Without extending these remarks on a subject, which I satisfy myself with recommending once more to your special regard, I have to invite your attention also to the gold assay. This is not performed, it appears, on precisely the same principles by different assayers. The opinion has been generally entertained by writers on this subject, and is conformable to practical results, that when gold & silver are combined, in the largest proportion of the latter which admits of its being abstracted by the nitric acid without deranging the continuity of the gold cornette, there will remain after the operation a minute residue of silver not to be perfectly separated even by repeated portions of concentrated acid. Hence fine gold assayed in the usual manner is heavier after the operation than before. The difference is equivalent to the weight of the silver protected by the gold and retained. A counter weight is therefore employed, to represent the retained silver. This gives true results, the procedure and the strength of the several courses of acid employed, being uniform. When in a compound of gold and silver, the latter sensibly exceeds three fourths of the mass, as in the ordinary process of parting in the large way, in which also a quick action of the

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acid is promoted, the gold is left in a state of extreme division, and the exposure of the silver is thereby complete. Repeated ~~cousses~~ ^ of acid, will in this case detach the silver so as to leave no appreciable residue. In the ordinary gold assay however, the wish of the operator is to retain the gold in a consistent form so that no particle may be detached and lost. He therefore uses the least proportion of silver consistent with the free action of the acid, and commences the solution slowly and with an acid somewhat reduced. You will in the progress of your researches learn whether foreign assayers of the first celebrity, employ in the gold assay that proportion of the materials which will preserve the assay piece unbroken, and whether it is nevertheless assumed, that the nitric acid perfectly removes the silver. If so how many ~~courses~~ of the acid and of what strength are employed; and if otherwise, what allowance is made for the silver retained, and does this allowance vary in any settled ratio to the degree of fineness of the gold assayed. —

3. A carefull examination is particularly recommended ~~recommended~~ of the combinations and machinery employed to facilitate the processes of the melting room & the operations of the coining department. The operations in many particulars employed in France, differ much from those of England, though the vast amount of coinage executed annually for a long period in both would suggest the idea that frequent comparisons ~~should~~ should have much more assimilated their processes and combinations. It would seem from this circumstance, that the value of the difference is not very

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manofact. —

The method of milling employed in the Mint of the United States, it is believed, is much the same as in France and England. The principal it is understood was first applied in France, and from thence transferred to the British Mint, under an engagement to the inventor, to preserve the operation secret. We have more to communicate than to learn probably under this head; and the same remark is confidently made in ~~the~~ regard to the device for cutting out planchets, introduced by the chief-coiner. The press in use with us for hardening dies, (employed by him since 1796) which is also due to Mr Eckfeldt, it is believed has been adopted in England. All that differs from us, however, in those long established institutions, will possess some interest, even if inferior or not meriting imitation.

You delineate with facility — please exhibit in this manner whatever can so be best illustrated — make copious notes — omit no enquiry where real information is attainable, and leave nothing to memory.

In addition to the above observations on the three chief subjects of examination, I have to call your attention, in the way of my Chief's Memoranda, to a variety of particulars, in the desultory manner in which they occur to me.

Assay balances are said to be best made in Paris — enquire and inform me in regard to quality and price. A pattern set of instruments for the humid assay, will be required of course, if this mode of assay be approved.

The best process for manufacturing nitric & sulphuric acid — The former is furnished here by our

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manufactures of the strength of 32° of Baume at 16cts per pound averdupoise. The latter, well concentrated, at 5cts. The kilogram, by which proportions and prices will be quoted to you in France, contains 15434 troy grs. The pound troy contains as you know 5760 grs. of which 7000 make the pound averdupoise. It is a very near approximation to say, that the Kilogram is equal to 2 2/3 lbs. troy, and 2 1/10 lbs. averdupoise. —

Assay. Furnaces for cupellation with their accompaniment the muffle — what the best construction — every minute circumstance to be regarded with attention. Messr Aubrey and D'Arcet, are said to have devised a very superior one — portable, and giving accurate results from very minute assays — say one grain for the assay, and 4 to 7 grs. of lead — the time 12 to 15 minutes — see Encyclop. Brit. supplement, page 572 to 577 article Assaying.

A gold ring is to be assayed, or small piece of silver — and not to be sensibly defaced — query, the method, and degree of accuracy pertaining to such assays.

Writers on assaying — Fillet about the year 1758 much celebrated — Vauquelin at a late period, and Thenard still more recently — the latter on this subject translated by Children.

Melting vessels — the different kinds employed in various operations for gold and silver. Wrought Iron vessels employed it is said in France, and emptied as with us by dipping. Cast iron, as with us, employed in England, and emptied by pouring — a field for much observation and important to an exact economy. —

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A pyrometer - to be relied on for high temperatures - One devised by the Director of the Mint at Benares in India, is said to possess superior merit. The melting point of gold, - of silver, - perhaps about 1200° for the latter and the former 5000°. Writers differ 2000° in these results, which indicate great imperfections in the pyrometers used. See Mr. Bland's ingenious theory for obtaining the fusing point of different Metals from the combining ratio & their tenacity and specific gravity. Trans. Am. Phil Society for the year

Does any assayer within the range of your observation rely on a pyrometer to determine the state of his cupels furnace - or the eye chiefly.

The pot assay - that of a small portion of the metal dipped out from the centre of the vessel during fusion - Is it in ordinary use, or chiefly the assay of the bar after casting. What the extreme deviation from the proper standards, in excess or defect, at which an ingot prepared for coinage is passed by the assayer.

Cupels - Are those of the ordinary form, viz. shallow caps, employed, or deep caps - is the effect more constant if the latter are employed.

Are assays repeated by a second assayer before they are approved - what difference in their reports requires a farther trial.

Manner of agitating the fused metal to insure a perfect mixture - Is this regularly attended to -

Every thing that can improve the assay process is important. Its accuracy is of moment to other interests than those pertaining to the Mint. Of all the processes of equal rank it seems to have attracted the least attention in the United States, except as connected with coinage. The Lead employed in cupellation is obtained from Litharge - is it free from Silver, or allowed for.

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In the melting department of the Mint arise many forms of refuse - sweepings - filings - pulverized melting vessels &c - all containing a portion of precious metal. These are rendered very lean by frequent washings, until the labour is no longer repaid by the product. Notice with care the most effectual contrivances for triturating the waste, and recovering all that it will produce. If at any stage of this opperation the waste is disposed of by sale - at what stage and at what general rate for a given quantity.

Copper for alloy of gold & silver - whence derived, and in what state of preparation - and at what price. Is it refined at the Mint or at private establishments. The process of pickling as it is called, to clean the surface of all extraneous discolouration, and give a sightly complexion to the metal - an important subject of enquiry.

Ascertain with great care in Paris, from the best authorities, the relative value of the gold & silver coins of France - the ratio by legal regulations is 15½ to 1, and both are, as in the United States, a general tender. Does Gold bear a premium on this ratio - what is the ordinary amount of this, and what its extremes under ordinary circumstances. What the proportional value of standard gold and silver bullion in the market and at the Mint.

A deposite is made at the Mint - after what delay is the assay effected, & a certificate of value rendered, in regard to both gold and silver. What interval in each case before payment of the value. What deduction made as a charge for coinage. These facts required as to both France

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and England.

Copper for coinage - whence procured - the price as received at the Mint - is it refined in the Mint or by private refineries - What vessels used for melting copper. Are all the preparatory processes for copper coinage performed in the Mint as in regard to gold & silver, or partly at private establishments. What is the weight and value of the lowest circulating coin - does this consist wholly of copper - are counterfeit issues of this coin frequent.

Annealing furnaces, stoves or devices of whatever kind - their form for ingots - strips, planchets, &c - for gold - for silver - for copper, - the kind of fuel employed for these operations.

The construction of grates for all furnaces, and boilers, including those of the steam engine.

Hardening dies in France - how performed - do these dies stand well. How many pieces struck with one pair of dies in France - in England. Is our hardening process employed in the British Mint - if not what method prevails there. Medal dies how hardened.

At how much less than full Mint weight are gold & silver coins a legal tender by tale, in France and in England. When reduced below this by use, are they still a legal tender by weight - what limit to this. To what amount are copper coins a legal tender, in France & England.

What is the annual waste by use in a series of years on gold and silver coins - in France, - in England, on coins of different denominations. We have the result of some experiments in England, none in France.

Are iron boilers used for the solution

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of iron by the sulphuric acid, in any of the processes. Why not, since concentrated sulphuric acid does not act on iron.

Whatever can be added to our information in regard to the treatment of the precious metals, and Mint process and machinery, is within the scope of your enquiries. In prosecuting them under the patronage and influence of the representatives of our government abroad, it will occur to you, that the courtesies and facilities conferred under this influence, are not to be made available for obtaining without permission, facts which it may be the prevailing policy to withhold. It is however confidently anticipated that in regard to the processes in contemplation in which it concerns the general community of Nations that the utmost ~~freedom~~ perfection be attained, nothing will be withheld in National establishments. This persuasion is the more readily entertained, because the liberality it supposes is always ~~extended~~ cheerfully extended here. All intelligent foreigners of respectable character, witness our processes without restraint. Every thing is open to their observation, and all their enquiries are ingenuously satisfied.

It may be that your researches shall develope little in regard to Mint operations, that can be profitably adopted here. It is however due to the character of this institution, that this supposition be not hastily ruled out. The appointment of Experts that the Director shall report at the next Session on the state subject of the Mint establishment presents moreover an occasion peculiarly fit for the investigation now confided to you.

Many of the enquiries then presented, will not be required to be closely applied to — Many also of the above suggestions will soon be superseded by the progress of your researches, which will offer them with other associated topics to your own reflection. They are presented

to your Notice now, in order that the general labours of inquiry may be early rendered familiar. Other particulars may be communicated hereafter as they shall occur.

Improvements capable of being rendered beneficial to the public in various departments of the Arts, may incidentally become objects of your attention — the economy of the Mint and the treatment of the precious Metals being always the first. — The illumination of cities with gas, offers itself prominently as an object in regard to which it may occur that valuable duties shall be acquired — The art of bronzing may be mentioned as a minor object. The Napoleon Medals are beautiful specimens of this art, which must therefore have been highly perfected in France. I perceive that there noticed a reference to the Journal des connaissances pratiques, for 1827 No. 27, as describing the mode of bronzing employed by one artist of celebrity in this respect — others may be superior — I mention this art as a specimen of the minor objects — others will occur to you — This however is not wholly extraneous to the appropriate functions of a Mint. —

You will keep an accurate & expenditures with all exact precision. I have entire confidence in your disposition to govern them within due limits, as far as regards yourself. In regard to such changes as the instruction to be taught for at the appropriate schools, or in the different private laboratories, may involve, together with necessary materials & implements, I must rely much on your discretion — Fees for instruction in the best private laboratories may reasonably be expected, and these probably will be the best schools in regard to the [illegible] the learning of each & either and even for the apparatus. In special cases consult me, if the delay incident to this be

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admissible – The principal objects of your Mission are not, I presume, to be defeated by the consideration of a few months delay, and I trust you will be able to obtain the instructions for which you have applied to the

You will please to make your residence known to Wm Hottinguer & Co eminent Bankers in Paris. Through their house the proper remittances will be made to you, and to them any letters for you will be addressed until otherwise ordered.

With great respect
and Esteem
Your &c
Jas Monroe

Franklin Peale Esqr.

P.S. I enclose a few memoranda found in my papers, by Mr Richardson – through the last steps of the despatches in the foregoing memorandum appointment

J. M.

P.S. Mr Richardson has sent Lemaire me a few notes which I enclose

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Instructions

for Mr. Hale

May 7. 1833

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The economy of the process involves, of course, that there shall be the least possible waste of precious metals, viz: no waste, and demands that the agent employed shall be recovered, by adequate expedients, in the most productive forms.

An operation in magnitude is that in contemplation, and not a delicate analysis of a minute quantity—a business operation, in which the whole procedure shall have reference to large results. Every progressive step with the manipulation pertaining thereto is important, and should be rendered familiar. Excuse [a] minute illustration: A bar of goldish silver for example of 72 lbs troy, about 27 killogrames [sic], is carefully weighed and assayed—be sure that this assay is perfect, indicating the average fineness of the mass. This bar is granulated, exposing thereby an extended surface to the action of the acid.— How granulated in the best laboratories is well done here, is it better done abroad? A certain weight is then introduced into a proper vessel, of a given size and form, and the acid poured thereon. What weight—what vessel, and size and form—and how much acid—and of what degree of purity and strength; and how are the purity

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and strength determined. Is the metal or the acid first introduced—the whole quantity of both either at once, or in divisions. What precautions to obviate disaster in the process, what the contrivances for disposing of the offensive vapors. Of the given acid, what quantity dissolves a given weight of silver variously alloyed, in what time, at what temperature. Is the solution saturated with the first dose of silver, or is the acid used, partially to dissolve the silver and then reserved to be poured on a fresh quantity. The solution is at last, it is presumed, a saturated solution, and at the end of the process is at the boiling temperature. What guards to prevent explosion in decanting the solution – how can it be diluted without danger while at the boiling point of concentrated sulfuric acid, and how prevent crystallization in cooling if not promptly diluted. How soon can the whole of the silver be precipitated—what is the precipitant preferred, and how is this best recovered in an available form. The gold is cleared of the sulfate of silver by the filter, then dried and melted—cleared by the filter—highly important device to be studied

well. It is dried—how dried—how melted—with what additions—in what vessels—with slow or rapid fire. When melted with every precaution and the gold bar assayed, if all parts of the process have been perfectly successful, the weight should correspond with the indication of the assay, and the gold should be perfectly fine. But it is probable that the gold will not be perfectly fine, the weight of the bar should therefore be

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greater than that of the gold indicated, and on being assayed should be found to contain the whole quantity of gold estimated to be in the original mass. A corresponding process is applicable to the silver after precipitation until corresponding results. Does the acid dissolve every particle of silver—even when the disproportion of this to the gold is such, that the latter is reduced by the process of parting to a state of the most minute division.

The process having been persued [sic] successfully throughout all its details in a single bar, the question of quantity to be accomplished in a given time, is merely one of proportion in the several parts of the establishment, and the constituents of the operation.

Devise and delineate the best plan of a Laboratory, complete in all its appendages for the parting of gold & silver, regarding the process as an object of individual enterprise, profitably conducted, to a given extent per day. Please to exercise your ingenuity in perfecting such an arrangement, as shall combine the efficiencies and facility of the best conducted refineries within the reach of your observation. An apartment of the Mint 54 feet by 37, accommodated with numerous flues, may be appropriated to this purpose. Such a modification of the plan devised, as would be feasible in the apartment referred to, claims therefore your special consideration.

The precipitants [sic] used to recover the silver from its solution in the sulfuric acid, will vary according to the occasional demand for their

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respective sulphates. Ascertain well the most convenient boilers for concentrating the solution, and the crystallizing vessels employed in each case. The form and capacity of such vessels, it is believed, will influence sensibly the perfectness [sic] and magnitude of the crystals, on which their value in commerce very much depends.

In the memoirs on the subject of parting by the sulfuric acid which I placed in your hands, much preliminary information is found, and your personal observation and actual engagement in the laboratories must do the rest. The prices at which the parting is performed in France, for different alloys, are to be carefully ascertained. A very material object of your mission is to be regarded as unaccomplished, until you have become familiar with everything requisite for directing the formation of an establishment, de novo, embracing the proper structures, arrangements, implements and facilities, and until you shall have acquired a good share of adroitness in the actual manipulations, from the granulation of the metal, until its component parts are separately recovered, and the agents recovered back under the most available forms.

In what has been hitherto said of parting by the sulfuric acid, which I placed in your hands, much preliminary information is found. Your own personal observation and actual engagement in the Laboratories must do the rest. The prices at which the parting is performed in France, for different alloys, are to be carefully ascertained. A very material object of your mission is to be regarded as unaccomplished, until you have become familiar with everything requisite for directing the formation of an establishment, de novo, embracing the proper

structures, arrangements, implements and facilities, and until you shall have acquired a good share of adroitness in the actual manipulations, from the granulation of the metal, until its component parts are separately rendered, and the agents recovered back under the most available forms.

In what has been hitherto said of parting by the sulphuric acid, the refineries of France have been especially in view. It is however stated on respectable authority, that this process has been very lately adopted, with some improvements, in London. These also, should your visit be extended to that place, it will claim your attention.

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2. The Assay of silver by the humid mode, will be an object also of very careful regard. The memoir of the commission charged by the French government in 1829–1830 with an investigation of this process, has been placed in your hands; from which you will have perceived the grounds on which this proceeding was founded. I have briefly alluded to them in my communication to the Secretary of the Treasury.

We are well aware, that the process of cupellation is not perfectly free from irregularities. These have, however, been so carefully considered and guarded against here, by judicious precautions and corrections, that it is believed the silver assay by cupellation is nowhere performed with more success. But with all these corrections it cannot be rendered invariably correct in a given instance, though its inequalities may neutralize each other in a succession of assays. If the humid assay for silver can be rendered facile and expeditious enough for daily practice, the achievement will be highly useful. The theory of the process assimilates it with the gold assay in the consistency of its results. The accuracy of the ordinary gold assay depends on that law by which the nitric acid dissolves all the silver from a mixture of silver and gold, or leaves always a given residue of silver undissolved. The accuracy of the proposed silver assay, by the humid way, depends on the precision with which the silver thus dissolved can be precipitated and its quantity determined, either by means of the precipitate itself, or of the material

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required to effect the precipitation. The latter has been recommended by the commission alluded to, and may therefore be regarded as on the whole preferable. It seems however to be the more protracted of the two. You will carefully study this process, if it be still in practice in Paris, and become perfectly acquainted with it by frequent repetition thereof with your own hands, under various proportions of different alloys skillfully combined as tests of the operation.

In thus prominently inviting your attention to the humid assay for silver, it is far from my purpose that you should omit to become perfectly familiar also with the assay by cupellation as performed abroad. It is altogether probable that, for its facility and brevity, this is still much in use in assay offices and refineries in Paris. In some one or more of these, the best being as far as possible selected, it would be useful to become intimately acquainted with the whole art of the cupel furnace as employed there. In England the dry assay for silver still, it is understood, prevails, guarded and checked, probably by methods analogous to those adopted here. In that country, therefore, in the event of your visiting it, this process will be critically investigated.

Much depends, you will have perceived from the reports of the French Commission, as well as from other authorities, in the quantity and quality of the alloy in determining the degree in which the result of the cupel assay is erroneous as commonly applied. Not a

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little also depends on the fit proportion of lead required by the variable character of the alloy present. A good series of these proportions is given by Aitkin. That followed here proceeds on similar principles. You will ascertain those which practice has suggested to the most skilful [sic] and experienced assayers abroad.

Without extending these remarks on a subject, which I satisfy myself with recommending once more to your special regard, I have to invite your attention also to the gold assay. This is not performed, it appears, on precisely the same principles by different assayers. The opinion has been generally entertained by writers on the subject, and is conformable to practical results, that when gold & silver are combined in the largest proportion of the latter, which admits of its being abstracted by the nitric acid without deranging the continuity of the gold cornette, there will remain after the operation a minute residue of silver not to be perfectly separated even by repeated courses of concentrated acid. Hence fine gold assayed in the usual manner is heavier after the operation than before. The difference is equivalent to the weight of the silver protected by the gold and retained. A counter weight is therefore employed to represent the retained silver. This gives true results, the procedure and the strength of the several courses of acid employed, being uniform. When in a compound of gold and silver, the latter sensibly exceeds three fourths of the mass, as in the ordinary process of parting in the large way, in which also a quick action of the

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acid is promoted, the gold is left in a state of extreme division, and the exposure of the silver is thereby complete. Repeated courses of acid will in this case detach the silver so as to leave no appreciable residue. In the ordinary gold assay, however, the wish of the operator is to retain the gold in a consistent form so that no particle may be detached and lost. He therefore uses the least proportion of silver consistent with the free action of the acid, and commences the solution slowly and with the acid somewhat reduced. You will in the progress of your researches, learn whether foreign assayers of the first celebrity, employ in the gold assay that proportion of the materials which will preserve the assay piece unbroken, and whether it is nevertheless assumed, that the nitric acid perfectly removes the silver. If so, how many courses of the acid and of that strength are employed; and if otherwise, what allowance is made for the silver retained, and does this allowance vary in any settled ratio to the degree of fineness of the gold assayed.

3. A careful examination is particularly recommended of the combinations and machinery employed to facilitate the processes of the melting room, or the operations of the coining department. The operations in many particulars employed in France, differ much from those of England, though the vast amount of coinage executed annually for a long period in both would suggest the idea that frequent comparisons should have much more assimilated their processes and combinations. It would seem from this circumstance, that the value of the difference is not very

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manifest.

The method of milling employed in the Mint of the United States, it is believed, is much the same as in France and England. The principle it is understood was first applied in France, and

from thence transferred to the British Mint, under an engagement to the inventor, to preserve the operation secret. We have more to communicate than to learn probably under this head; and the same remark is confidentially made in regard to the device for cutting out planchets, introduced by the Chief Coiner. The process in use with us for hardening dies (employed here since 1796), which is also due to Mr. Eckfeldt, it is believed has been adopted in England. All that differs from us however, in those long established institutions, will possess some interest, even if inferior or not meriting imitation.

You delineate with facility—please exhibit in this manner whatever can so be best illustrated—make copious notes—omit no enquiry where real information is attainable, and leave nothing to memory.

In addition to the above observations on the three chief subjects of examination, I have to call your attention, in the way of using brief memoranda, to a variety of particulars, in the desultory manner in which they occur to me.

Assay balances are said to be best made in Paris—enquire and inform me in regard to quality and price. A pattern set of instruments for the humid assay, will be required of course, if this mode of assay be approved.

The best process for manufacturing nitric & sulphuric acid—the former is furnished there by our

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manufacturers of the strength of 32° of Baume at 16 cents per pound avoirdupois. The latter, well concentrated, at 5 cents. The killogram, by which proportions and prices will be quoted to you in France, contains 15,434 troy grains. The pound troy contains as you know 5,760 grs. of which 7,000 make the pound avoirdupois. It is a very near approximation to say that the killogram is equal to 2-2/3 lbs, troy, and 2-1/5 lbs avoirdupois.

Assay furnaces for cupellation with their accompaniment, the muffle—. What the best construction—every minute circumstance to be regarded with attention. Messrs. Aufrey and D'Arcet, are said to have devised a very superior one—portable, and giving accurate results from very minute assays—say one grain for the assay, and 4 to 7 grs. of lead. The time 12 to 15 minutes—see Encycl. Britan. supplement, page 572 to 577, article "Assaying."

A gold ring is to be assayed, or small piece of silver—and not to be sensibly defaced—query, the method and degree of accuracy pertaining to such assays.

Writers on assaying. [Mathieu] Tillet about the year 1758* much celebrated— [Louis Nicolas] Vauquelin at a late period, and [Louis Jacques] Thénard still more recently the latter on this subject translated by [John George] Children.

Melting vessels—the different kinds employed in various operations for gold and silver. Wrought iron vessels employed it is said in France, and emptied as with us, by dipping. Cast iron, as with us, employed in England, and emptied by pouring. A field for much observation and important to an exact economy.

** Probably referring to:* Hellot, Tillet et Macquer, *"Mémoire sur les effais des matieres d'Or & d'Argent"(Paris, 1763);* Tillet, *"Mémoire sur un moyen nouveau de faire avec exactitude, et tout-à-la-fois, le depart de plusieurs essais d'or, dans un seul et même matras (Paris,1779);" and "Mémoire sur un moyen nouveau de faire avec exactitude, le départ d'un grand nombre d'essais d'or à différens titres : & d'appliquer dans le même temps cette opération à tous ces essais réunis dans un seul matras (Paris, 1781)".*

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A pyrometer to be relied on for high temperatures. One devised by the director of the Mint at Benares in India, is said to possess superior merit. The melting point of gold, of silver—perhaps about 4,000° for the latter and the former 5,000°. Writers differ [by] 2,000° in these results, which indicates great imperfections in the pyrometers used. See Mr. Claud's ingenious theory for determining the fusing point of different metals from the combined ratio of their tenacity and specific gravity. From Am. Phil Society for the year….

Does any assayer within the range of your observation rely on a pyrometer to determine the state of the cupel furnace—or on the eye chiefly.

The pot assay – that of a small portion of the metal dipped out from the center of the vessel during fusion. Is it in ordinary use, or chiefly the assay of the bar by casting? What the extreme deviation from the proper standard, in excess or defect, at which an ingot prepared for coinage is passed by the assayer.

Cupels. Are those of the ordinary form, viz.: shallow cups, employed, or deep cups—is the effect more constant if the latter are employed.

Are assays repeated by a second assayer before they are approved—what difference in their reports requires a further trial.

Manner of agitating the fused metals to insure a perfect mixture— Is this regularly attended to—

Everything that can improve the assay process is important. Its accuracy is of moment to other interests than those pertaining to the Mint. Of all the processes of equal rank it seems to have attracted the least attention in the United States, except as connected with coinage. Is the lead employed in cupellation [free] from litharge – is it free from silver or is the silver allowed for.

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In the melting department of the Mint arise many forms of refuse—sweepings, filings—pulverized melting vessels &c.—all containing a portion of precious metal. These are rendered very lean by frequent workings, until the labour is no longer repaid by the product. Notice with care the most effectual contrivances for saturating the waste and recovering all that it will produce. If at any stage of the operation the waste is disposed of by sale — at what stage and at what general rate for a given quantity.

Copper for alloy of gold & silver—whence derived, and in what state of preparation—and at what price. Is it refined at the Mint or at private establishments. The process of pickling as it is called, to clean the surface of all extraneous discoloration and give a sightly complexion to the metal—an important subject of inquiry.

Ascertain with great care in Paris, from the best authorities, the relative value of the gold & silver coins of France—the ratio by legal regulation is 15-5/10 to 1, and both are, as in the United States, is general tender. Does gold bear a premium in this ratio—what is the ordinary amount of this, and what its extremes under ordinary circumstances. What the proportional value of standard gold and silver bullion in the market and at the Mint.

A deposit is made at the Mint—after what delay is the assay effected, & a certificate of value of rendered in regard to both gold and silver. What interval in each case before payment of the value. What deduction made as a charge for coinage. These facts required to be as to both France

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and England.

Copper for coinage—whence procured—the price as received at the Mint—is it refined in the Mint or by private refineries. What vessels used for melting copper. Are all the preparatory processes for copper coinage performed in the Mint as in regard to gold & silver, or partly at private establishments. What is the weight and value of the lowest circulating coin—does this consist wholly of copper—are counterfeit issues of this coin frequent.

Annealing furnaces, stoves or devices of whatever kind—their form for ingots, strips, planchetts [sic], &c.—for gold, for silver—for copper—the kind of fuel employed for these operations.

The construction of grates for all furnaces and boilers, including those of the steam engine.

Hardening dies in France—how performed—do their dies stand well. How many pieces struck with one pair of dies in France — in England. Is our hardening process employed in the British Mint—if not what method prevails there. Medal dies how hardened.

At how much less than full Mint weight are gold & silver coins a legal tender by tale, in France and in England. When reduced below this by use, are they still a legal tender by weight—what limit to this. To what amount are copper coins a legal tender, in France & England.

What is the usual waste by use in a series of years on gold and silver coins—in France, in England, on coins of different denominations. We have the result of some experiments in England, none in France.

Are iron boilers used for the solution

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of silver by the sulphuric acid, in any of the refineries. Why not, since concentrated sulphuric acid does not act on iron.

Whatever can be added to our information in regard to the treatment of the precious metals and Mint processes and machinery as is within the scope of your enquiries. In prosecuting them under the patronage and influence of the representatives of our government abroad, it will occur to you, that the courtesies and facilities conferred under this influence, are not to be made available for obtaining, without permission, facts which it may be the prevailing policy to withhold. It is, however, confidently anticipated that in regard to the processes in contemplation in which it concerns the general community of Nations, that the intimate perfection should be attained, nothing will be withheld in National establishments. This persuasion is the more easily entertained, however the liberality it supposes is always cheerfully intended here. All intelligent foreigners of reputable character, witness our processes without restraint. Everything is open to their observation, and all their enquiries are as ingeniously satisfied.

It may be that your researches shall develop little in regard to Mint operations, that can be profitably adopted here. It is, however, due to the character of these institutions that this expectation be not hastily relied on. The requirement of Congress that the Director shall report at the Mint [?] on the whole subject, of the Mint establishment, presents moreover, an occasion particularly fit for the investigation now confided to you

Many of the enquiries thus presented, will not be required to be directly replied to—many also of the above suggestions will soon be superseded by the progress of your research, which will offer them with other assorted topics to your own [initiation ?]. They are presented

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to your notice now, in order that this general scheme of inquiry may be early rendered familiar. Other particulars may be communicated hereafter as they shall occur.

Improvements capable of being rendered beneficial to the public in various departments of the arts, may incidentally become objects of your attention — the concerns of the Mint and the treatment of the precious metals having always the first. The illumination of cities with gas, offers itself prominently as an object in regard to which it may occur that valuable data shall be acquired. The art of bronzing may be mentioned as a minor object. The Napoleon Medals are beautiful specimens of this art, which must therefore have been highly perfected in France. I perceive that I have noted a reference to the "Journal des connaissances [usuelles] et pratiques," for 1827 No. 27, as describing the mode of bronzing employed by one artist of celebrity in this respect—others may be superior. I mention this art as a specimen of the minor objects — others will occur to you. This however is not wholly extraneous to the appropriate functions of a Mint.

You will keep an account of expenditures with all useful precision. I have entire confidence in your disposition to pursue them within due limits, as far as regards yourself. In regard to such charges as the instruction to be sought for at the appropriate [schools], or in the different private laboratories, may involve, together with necessary materials & implements, I must rely much on your discretion. For for [sic] instruction in the best private laboratories may reasonably be expected, and these probably will be the best [ ] to the parting of gold and silver, as was for the assay. In special cases consult me, if the delay incident to this be acceptable.

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acceptable. The prominent objects of your mission are not, however, to be dissipated by the consideration of a far next palpably con [ ]ant.

You will please to make your residence known to Messrs. Hottinguer & Co. investment bankers in Paris. Through their house the proper remittances will be made you, and to their care my letters for your will be addressed announced.
With great respect and esteem
Yours etc.
Sam'l Moore

Franklin Peale Esqr.

P.S. Mr. Richardson has just handed me a few notes which I enclose—

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[Abstract]

Instructions
for Mr. Peale
May 7, 1833
2211